Executive Summary

TFMoran was retained by the City of Manchester to study the hydrology of Ray Brook from the Dorr's Pond Dam to the Merrimack River. The purpose of this study was to analyze the ability of the culverts and channels along the brook's waterway to accept stormwater runoff, to identify problem areas and flow restrictions, and to provide recommendations to improve the capacity of the waterway and reduce the frequency and severity of flooding of roads, sewers, storm drains, and private property within the watershed.

Because the Dorr's Pond Dam does not conform to current NHDES rules, the scope of the study was expanded to analyze the hydraulic capacity of the dam and spillway, and to investigate ways to bring it into conformance with the requirements for a Class C "High Hazard" dam as it is now listed by the NHDES.

Ray Brook drains a 1,566-acre watershed stretching from South Hooksett across North Manchester to the Merrimack River. From its start in South Hooksett just west of NH28 By-Pass, it flows through Goldfish Pond in the southwest quadrant of the I93 Exit 9 interchange, then into Dorr's Pond and over a 9' high dam at its south end. From the Dorr's Pond Dam, the brook flows through a series of open channel and closed culverts to its terminus at the Merrimack River approximately 1,800' north of the Amoskeag Dam.

A hydrological model was developed using Hydrocad v9.00 software to simulate the behavior of Ray Brook under various storm intensities and configurations of the dam and spillway. The model incorporates a network developed by the NHDOT under a previous study of the Goldfish Pond and Dorr's Pond subwatersheds.

Problem Areas Needing Regular Inspection and Maintenance

1. **The grated inlet structure at Clarke & Walnut streets**. The grate is prone to clogging from leaves, branches, and other debris. This will cause local flooding and restrict the volume of flow entering the closed culvert system. The extent of flooding that will result from partial blockage of the grate was studied.

   Recommendation – The City should continue to follow its recently-updated Action Plan to inspect the grate and keep it clear of debris during storm events. Although the grate can tolerate 50% blockage without major effect, it is important that the City monitor the grate to ensure that it remains clear of any significant accumulation of debris, otherwise local flooding may result in the Walnut/Clarke area and a sudden release from clearing debris could cause a surge that temporarily exceeds the downstream capacity of the culvert system. This recommendation involves no additional cost to City.

2. **The artificial 4'x4' stone channel upstream of Clarke & Walnut streets**. This artificially confined channel flows through private property. Its capacity is exceeded starting in the 10-year storm, causing flooding in low-lying lawn areas of the adjacent residential properties.

   Recommendation – This channel is on private property and the damage risk from this condition for lower-intensity storms is to lawn areas only. As part of the Action Plan referred to above, the City should work with the property owners to ensure that they periodically inspect the channel to ensure the sidewalls are maintained in good repair and the channel is

kept free of debris and sediment to preserve maximum waterway capacity. No additional cost to City.

Problem Areas Needing Capital Improvements

1. **Dorr's Pond Dam.** According to the NHDES, the Dorr's Pond Dam is classified as a Class C "High Hazard" structure due to the extensive property damage that would be caused by a sudden breach. As a High Hazard dam, it must be stable under flow conditions 2.5 times greater than the 100-year storm. The current dam and spillway do not meet this criteria.

   Recommendation - After review of various other options, including: replacing the dam, installing a secondary spillway, raising the crest of the existing dam; the most cost-effective solution that ensures dam safety and meets the NHDES criteria is found to be strengthening and stabilizing the existing dam. The estimated cost of this option is $180,000.

2. **River Road box culvert**. The River Road box culvert restriction causes flooding of adjacent property beginning in the two-year storm event, and flooding of adjacent structures and roadway starting in the 25-year storm.

   Recommendation - The box culvert at River Road should be enlarged to allow more flow to pass and reduce amount of flooding over the roadway and abutting properties. Estimated cost is $640,000.

3. **The Elm Street box culvert**. Starting in the 25-year storm event, tailwater from the Elm Street box culvert begins to reduce the capacity of upstream reaches. In the 100-year storm, this tailwater will cause flooding to structures as far upstream as Clarke Street.

   Recommendation - The box culvert at Elm Street is substantially undersized and should be enlarged to allow more flow to pass through culvert and reduce tailwater effects on upstream portions of Ray Brook. Estimated cost: $1,475,000.

If necessary, these improvements can be implemented done in three phases, in the order shown below:

Phase 1	Dam stabilization	$180,000
Phase 2	River Road culvert replacement	$640,000
Phase 3	Elm Street culvert replacement	$1,475,000
Total Cost of all Improvements		**$2,295,000**

Please refer to the full Study Narrative for more details on all of these issues, as well as photos, hydraulic calculations, and cost estimates.